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RESEARCH ARTICLE

EMPIRICAL DISTRIBUTION FUNCTION OF HIGH BLOOD PRESSURE CASES BASING ON TEMPORAL, ANTHROPOMETRIC, AND METABOLIC FEATURES AT KORHOGO REGIONAL HOSPITAL

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Abstract

Background: The prevalence of high blood pressure (HBP) in Cote d'Ivoire was recently estimated at 38%. The present retrospective study, conducted at Korhogo Regional Hospital (KRH) between 2016 and 2021, aimed to analyze trends in hypertension cases increasing in Korhogo district and as well characterizing the associated factors such as time, age, sex, glycemia and cholesterolemia.
Methods: We performed a retrospective analysis on 2375 hypertensive patients. Clinical, biological i.e. glycemia and cholesterolemia and anthropometric parameters i.e. sex, age were collected, structuredand analyzed in R programming environment. We developed own script in R programing environment aiming to accomplish multivariate statistical surveys as well as applying several parametric and non-parametric tests.
Results: Findings revealed a significant yearly increase of high blood pressure cases, especially among individuals over 45 years of age ($p < 0.05$). In addition, results shown a strong positive correlation between hypertension patient's frequency increasing and ageing as opposite to sex and cholesterolemia parameters ($p > 0.05$). Of note, glycemia exhibited statistically significant correlation with ageing patients without a family history of hypertension, suggesting the importance of early screening in ageing adults and as well in monitoring metabolic factors i.e. glycemia, in monitoringhypertension.

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Conclusion: The progression of HBP in Korhogo appears strongly associated with patients ageing and temporal feature, especially for patients without HBP family history. In conclusion, this study suggests a key role of ageing and temporal features in explaining high blood pressure (hypertension) increasing cases and as well dynamics, in northern Cote d'Ivoire.

Introduction:

High blood pressure or hypertension remains a major public health issue worldwide. It is the leading preventable risk factor for premature death and disability, and the primary cause of morbidity and mortality globally [1]. Approximately 1 billion people are affected, and the condition accounts for an estimated 9.4 billion deaths annually [2, 3]. More than a quarter (26.4%) of the global adult population is hypertensive, and this proportion is projected to rise to 29.2% by 2025, representing nearly 1.6 billion individuals [4]. In low- and middle-income, countries, particularly in Africa, up to 46% of adults over 25 years are affected [5]. Cote d'Ivoire, like many African countries, is experiencing an exponential increase in this silent disease, with causes remaining unknown in more than 90% of diagnosed cases [6]. At the Korhogo Regional Hospital (CHR), hypertension is one of the leading reasons for consultation [6, 7]. However, few studies have documented its temporal evolution and its relationship with (i) biological features such as glycemia and cholesterolemia, demographic and anthropomorphic (sex and age) parameters.This study aimed to analyze the year-to-year dynamics of hypertension troubles cases recorded at the Korhogo Regional Hospital between 2016 and 2021, while exploring the influence cholesterolemia, glycemia and as well as anthropometricfeatures (sex and age) and demographic factors.

Material and Methods:

Sampling:

We conducted a retrospective study based on medical records of patients diagnosed with hypertension at theKorhogo Regional Hospital, in Northern Cote d'Ivoire, between 2016 and 2021.

Out of approximately 10030 patients seen in the cardiology unit during this period, 2375 records were retained for analysis. Among them, 2272 corresponded to hypertensive patients without a family history of hypertension, and 103 to patients with a family history.

The variables examined in this study included:

(i) Qualitative variables such as sex, sedentary lifestyle, self-medication, and family history;

(ii) Anthropometric and biological variables i.e. age, glycemia and cholesterolemia.

Statistical Analyses:

The anthropometric, biological, and clinical data collected from the target population were structured and processed using statistical analyses, primarily with the R software package. However, several descriptive statistical analysis were performed using both Excel and R. Analytical statistics were carried out exclusively through custom R scripts. The following statistical tests were applied:

(i) Student's t-test for comparing two means;

(ii) Fisher's test for assessing homogeneity of variances;

(iii) Tukey's test for multiple mean comparisons.

(iv) Chi-squared test to assess dependence or interdependence between qualitative variables (sex, sedentary lifestyle, self-medication, family history).

Age classes were determined according to Sturges' formula:

$k=1+3.3*\log_{10}(N)$;

where k is the number of classes and N is the number of observations.

We developed empirical cumulative distribution function with the purpose to evaluate hypertension cases growth dynamic according to age across different years. This method, closely related to empirical probability laws, provides a statistical foundation for analyzing the distribution of hypertension prevalence across time. The empirical distribution function is an important concept that is naturally linked to the notion of an empirical law. Both concepts are defined directly from a sample, and together they form the basis for the idea of natural statistics.

Let (Ω, T, P) a probability space;ξ : Ωα R a random with distribution Pξ, X = (X1... XN); considering a sample iiddrawn fromξand X (.) = (X (1), X (N)) denote the order statistics associated with X. The empirical distribution function of Pξ (or ofξ) associated with X as the defined function
F: R α [0, 1] such that:

- F(x)=0 if $x < X_1$,
- x ∈ R α F (x) = n / N si X(n) ≤ x < X(n+1), ∀ n ∈ N_{N-1},
- 1 if $X_{(N)} \leq x$.

The empirical distribution function can also be expressed as F (x) = N^{-1}. # {n ∈N_N: Xn≤ x} (the proportion of indices **n** such that Xn≤ x), considering E = Card E denotes the number of elements in the finite set E.
Simple linear regression is a classical statistical method used to evaluate the significance of a linear relationship between two continuous numerical variables. In other words, it is applied to determine whether two continuous variables are significantly related, under the assumption of a linear relationship. Herein, we applied simple linear regression to evaluate the correlation between the absolute frequency of hypertensive patients considered as response variable and time expressed in years and processed as explanatory variable. Because of the heterogeneity between the response variable (frequency of hypertensive patients) and the explanatory variable (years), we applied a logarithmic transformation to the data **[8].** The statistical significance threshold was set at $p < 0.05$.

Results:

Descriptive Analysis of Hypertension Dynamism in Patients without Family History:
The study sample included 2272 hypertensive patients including 1073 men and 1199 women (Table I). Of note, 379 (±10) new high blood pressure cases were recorded annually between 2016 and 2021. The frequency of hypertension increased steadily from 2016 to 2019, followed by a slight decline between 2019 and 2021. Female patients consistently outnumbered males until 2020, with a partial reversal observed in 2021.

Table I. Hypertensive patients recorded at Korhogo Regional Hospital (2016–2021)

	2016	2017	2018	2019	2020	2021	**Total**
Female	61	155	190	305	263	225	1199
Male	42	132	168	255	241	235	1073
Total	103	287	358	560	504	460	2272

Distribution of Hypertensive Patients Cases from 2016 to 2021:

The distribution of high blood pressure troubles over the study period showed a median of 409 cases, close to the mean (379), suggesting a symmetric, and near-normal distribution (Figure 1). The cumulative distribution function confirmed strong similarity between male and female patient groups. Median values were similar (≈200) and aligned with respectively with 206.5 and 178.8 values, representing female and male hypertension average cases. The Shapiro–Wilk test confirmed normal distribution across wholeanalyzed hypertensive population, as well as within male and female subgroups ($p > 0.05$) (Table II). These results indicate that the empirical function distribution of hypertension cases was independent of sex.

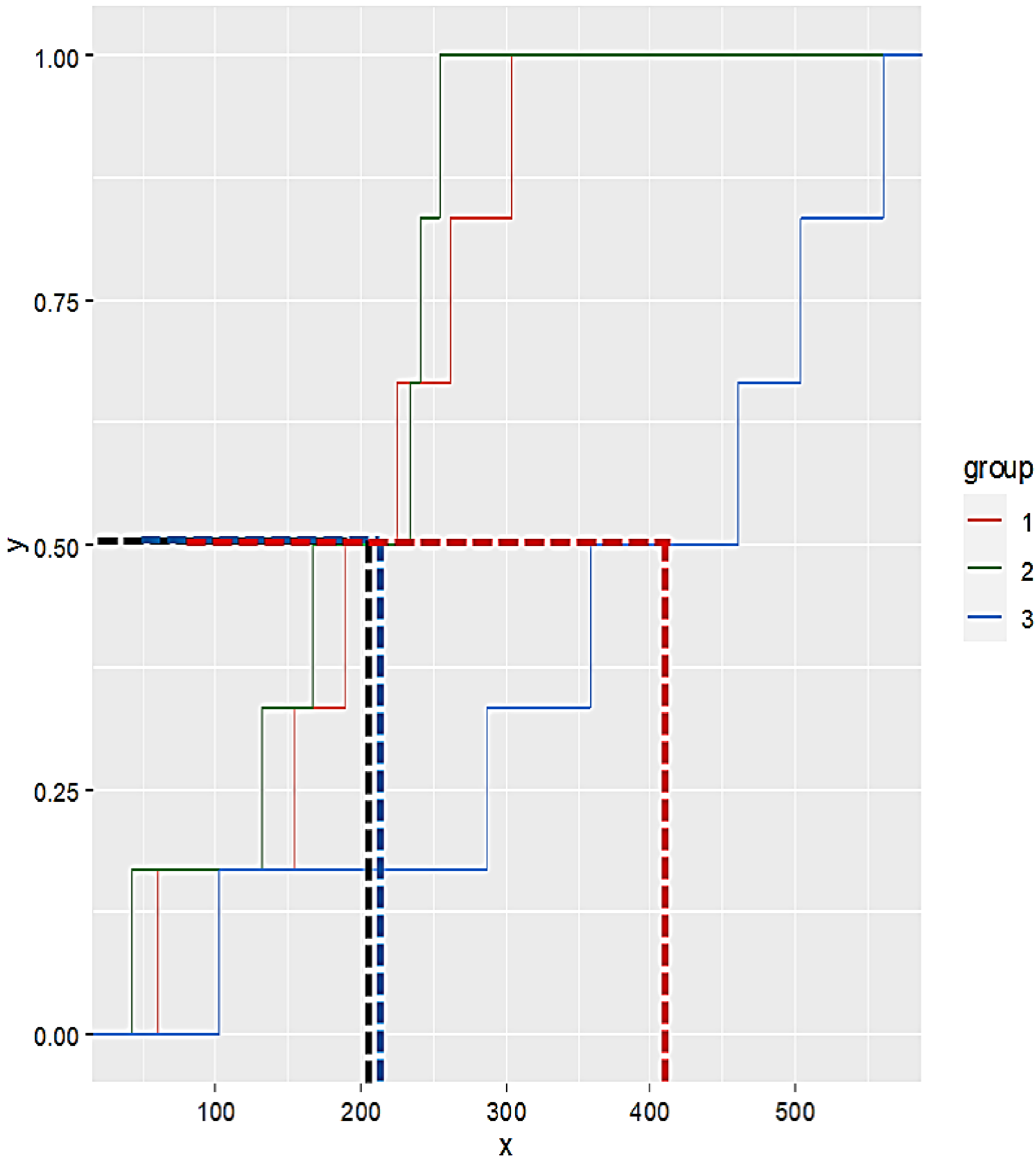

Figure 1. Distribution Function and Growth Dynamics of Hypertensive Populations at Korhogo Regional Hospital from 2016 to 2021.The x-axis represents the variable "yearly class" corresponding to the number of hypertensive patients, while the y-axis represents the frequency and/or probability of hypertension cases for each year (2016, 2017, 2018, 2019, 2020 and 2021). Groups 1, 2, and 3 refer respectively to female hypertensive patients, male hypertensive patients, and the overall hypertensive population.

Table II. Shapiro–Wilk test of normality for hypertensive populations (2016–2021)

Populations	W statistic	p
All patients	0.94	0.70
Female	0.98	0.93
Male	0,89	0,31

Yearly Variation in Hypertension Dynamics from 2016 to 2021:
The previous results showed a progressive increase in hypertension cases between 2016 and 2021 at the Korhogo Regional Hospital. This trend was confirmed by the analysis of inter-annual variance, which revealed highly significant differences comparing hypertension cases across considered years ($p = 0.00$). Of note, partial variance analysis, supported by Tukey's multiple comparison test, indicated significant differences between 2016, 2017, 2018, and 2019 when compared to one another and contrasted with those both 2020 and 2021 years (Figure 2A; Table III). It is noteworthy to underline that the years 2020 and 2021 differed from the earlier years in terms of hypertension cases growth dynamic, reflecting a non-uniform evolution in the number of cases recorded (Figure 2). General multiple comparative survey revealed a significant increase in the proportion of hypertension cases across the study period ($p < 0.05$; 95% CI), with confidence intervals being similar for the years; 2016, 2017, 2018, and 2020 by contrast years 2019 and 2021 (Figure 2B). The year 2019 showed a wider confidence interval, reflecting greater variability compared to 2021 year. However, statistical analysis did not reveal a significant difference between 2019 and 2021, suggesting a relative stabilization of hypertension cases during these two years.

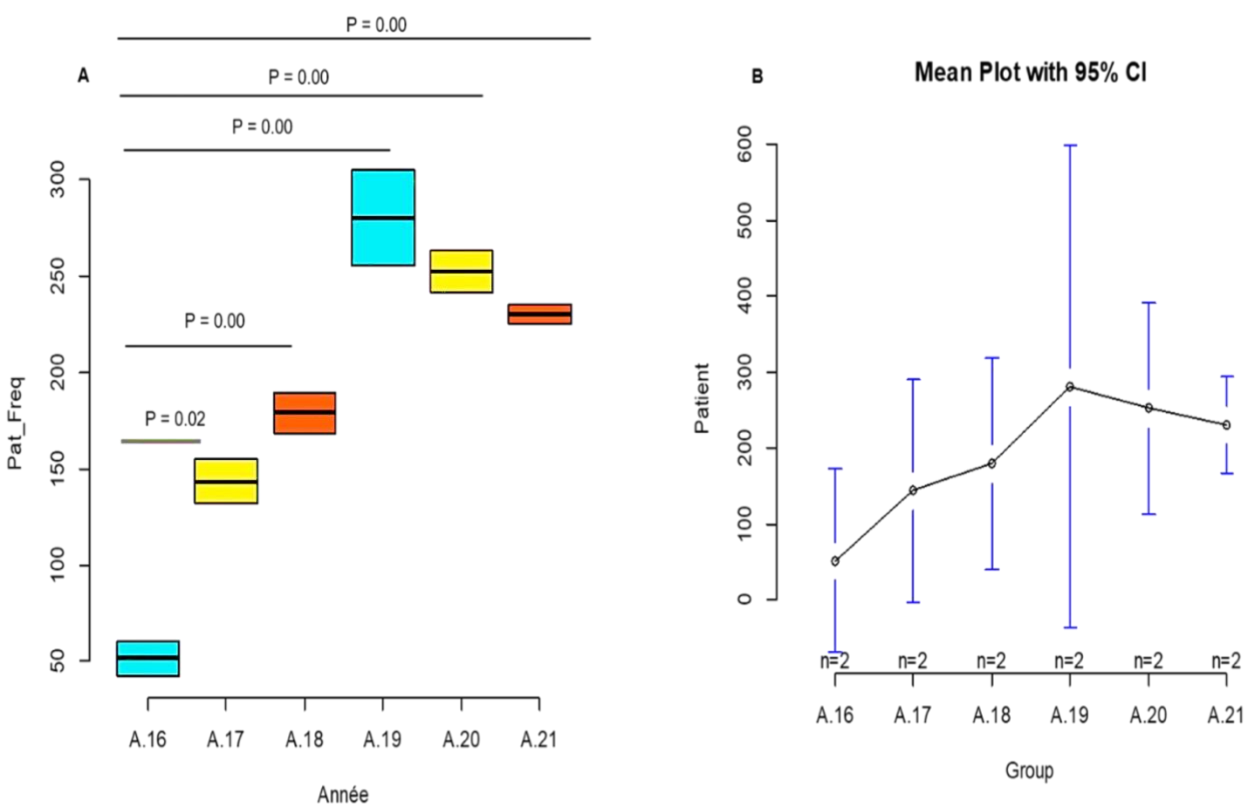

Figure 2. (A) Multivariate statistical comparative analysis associated to; (B) 95% confidence intervals of hypertensive populations at Korhogo Regional Hospital from 2016 to 2021.

Table III. Hypertensive patient's yearly comparison at Korhogo Regional Hospital (from 2016 to 2021.

Yearly Comparison	Difference	Lower Bound	Upper Bounder	P-value
A.17 – A.16	**92**	**15.29**	**168.71**	**0.02*****
A.18- A.16	**127.5**	**50.79**	**204.21**	**0.00*****
A.19 – A.16	**228.5**	**151.79**	**305.21**	**0.00*****
A.20 – A.16	**200.5**	**123.79**	**227.21**	**0.00*****
A.21-A.16	**201**	**152.79**	**226.21**	**0.00*****
A.18 – A.17	35.5	-41.21	112.21	0.51 NS
A.19 – A.17	**136.5**	**59.79**	**213.21**	**0.00*****
A.20 – A.17	**108.5**	**31.79**	**185.21**	**0.01*****
A.21 – A.17	**86.5**	**9.79**	**163.21**	**0.03*****
A.19 – A.18	**101**	**24.29**	**177.71**	**0.01*****
A.20 – A.18	73	-3.71	149.71	0.06 NS
A.21 – A.18	51	-25.71	127.71	0.22 NS
A.20 – A.19	-28	-104.71	48.71	0.7 NS
A.21 – A.19	-50	-126.71	26.71	0.23 NS
A.21 – A.20	-22	-98.70	54.71	0.85 NS

***** $P \leq 0.05$, NS $P > 0.05$.**

Linear regression model of hypertension cases frequency over time from 2016 to 2021:

The previous analysis highlighted a significant increase of high blood pressure troubles cases at Korhogo Regional Hospital between 2016 and 2021. This result indicates that time in terms of year, is a major explanatory factor for this trend. To assess this progression, we developed a linear regression model, considering the annual frequency of hypertension cases as the dependent variable (y; response variable) and the years as the independent variable (x; explaining variable). The resulting mathematical model equation (E) is expressed as followingE: $y=5.19x-10$ (Figure 3). This model shows strong statistical significance ($p = 0.00$) with a coefficient of determination $R2=0.70$, indicating that 70% of the observed variance in hypertension cases can be explained by year feature. Additionally, the Student's t-test applied to the model's estimators (5.19 and -10) is significant ($p < 0.05$). The Fisher test applied to the model further confirms its predictive validity ($p = 0.00$), suggesting that high blood pressure increasing cases follows a robust linear trend over the study period.

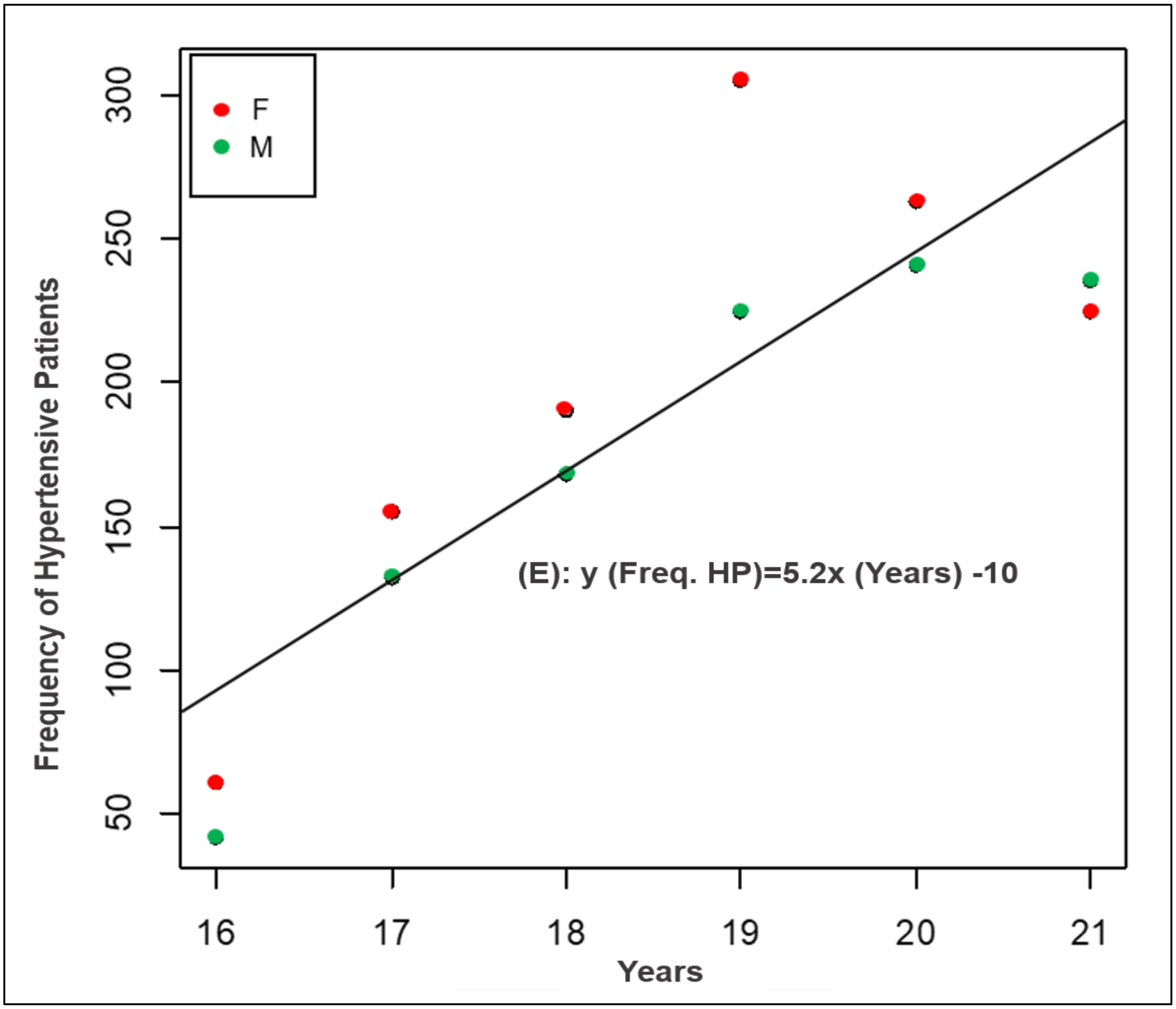

Figure 3. Linear regression model of the frequency of hypertensive patients over the period from 2016 to 2021. The acronyms F and M refer to female and male hypertensive patients, respectively

Assessment of the dynamics of the hypertensive population by gender:

Even if results suggested high blood pressure cases increasing regarding both male and female hypertensive patients from 2016 to 2021, it is noteworthy to underlinethat hypertensive population is predominantly female, with a peak of 115 new hypertension cases between 2018 and 2019, compared to 57 new cases for males (Figure 4). The ratio between the maximum and minimum of high blood pressure cases over the period running from 2016 to 2021 indicates a growth factor of 5 and 6 respectively for female and male hypertensive patients. However, analysis of variance (ANOVA) based on sex feature revealed variance homogeneity between female and male hypertensive populations (Figure 5A). In other words, the ANOVA test suggested a non-significant difference in terms of high blood pressure cases increasing between female and male hypertensive patients from 2016 to 2021 ($p = 0.67$) at a 95% confidence interval (Figure 5B).

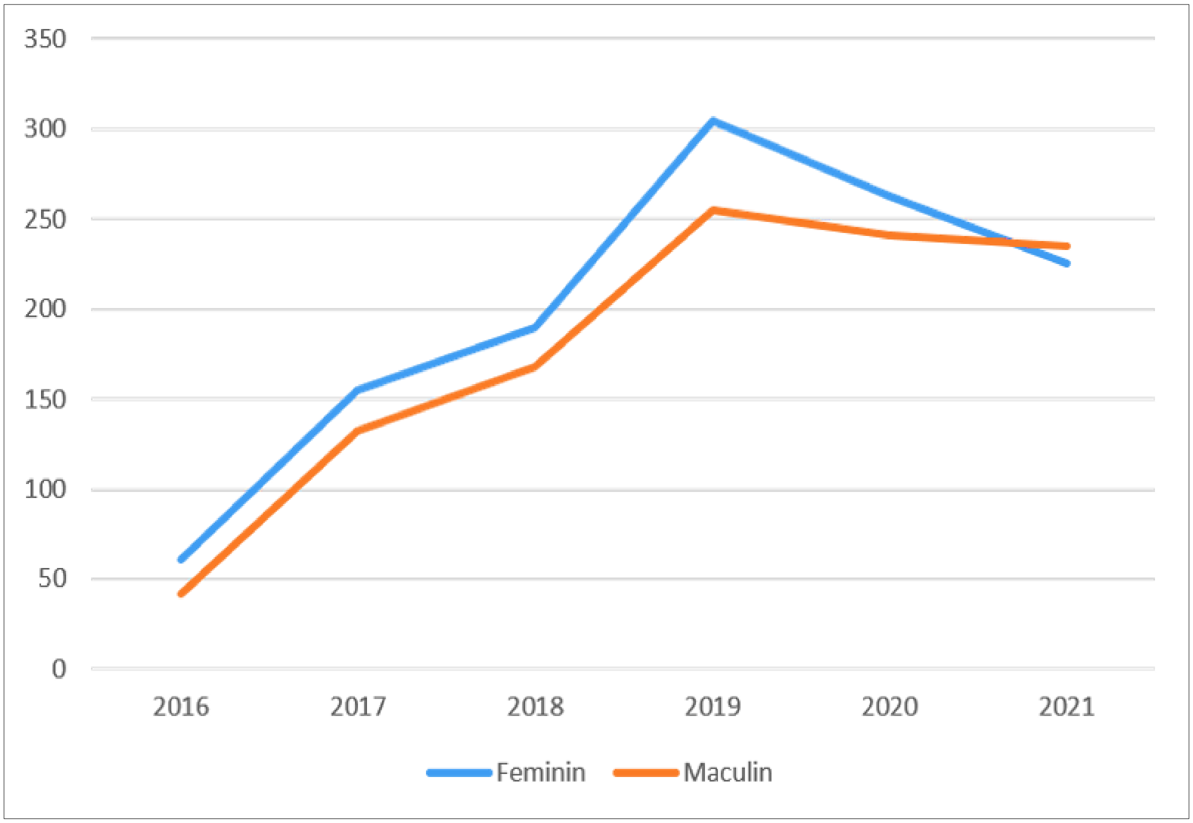

Figure 4. Comparative analysis of hypertension dynamics growth curves by sex.

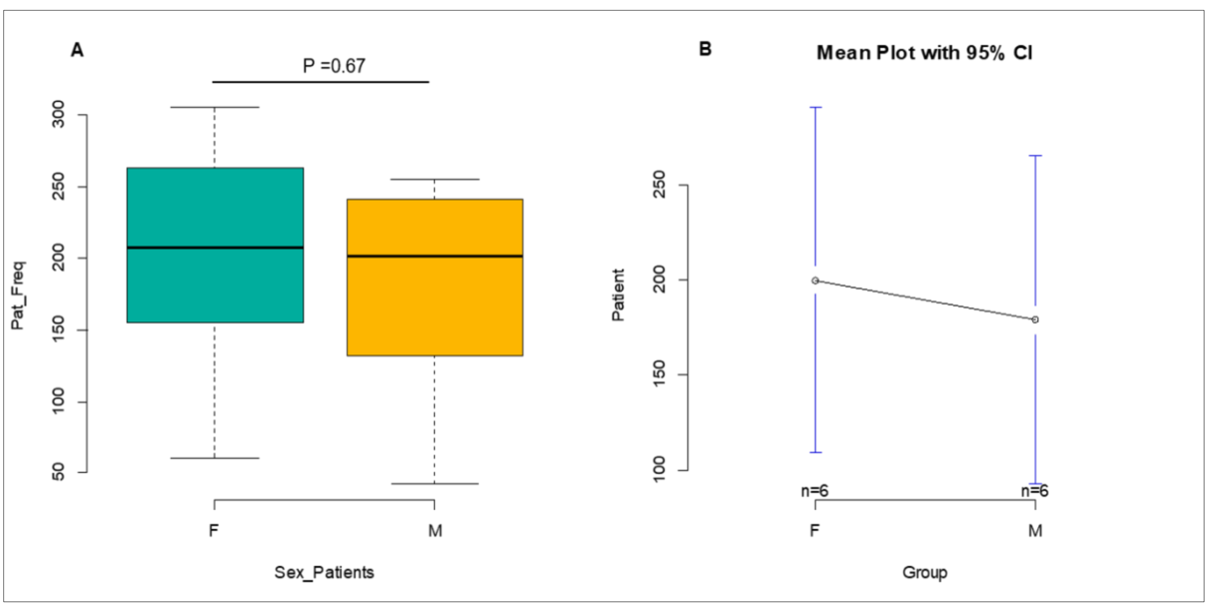

Figure 5. Multivariate comparative statistical analysis of variance between female (F) and male (M) hypertensive patients, CHR Korhogo, 2016–2021.

Correlation between age and high blood pressure (HBP)cases at KorhogoRegional Hospital from 2016 to 2021: A total of 2272 hypertensive patients, aged 15 to 101 years and clustered into 13 classes, were analyzed (Table IV). HBP patient'sage averageis 54 ± 10 years. The modal class being in the class interval 55-60 years for both female and male hypertensive patients. Pearson's correlation test revealed a strong positive link between ageing and hypertension increasing cases (R = 0.85, 95% CI [0.58–0.96], p < 0.001, df = 11) (Figure 6). Developed linear regression model (E) between anthropomorphic parameter age (hypertensive patient's age) and HBP cases increasing is as following; E: y=1.89x - 2.33, where slope = 1.89 (p < 0.001) and intercept = -2.33 (p = 0.10). The adjusted R2 was 0.71, indicating that age represented by x, explained 71% of the variance of HBP increasing cases. Fisher's test confirmed the model's validity (p < 0.001, df = 11), establishing ageing as a strong predictor of high blood pressurecases increasing in the analyzedhypertensive population.

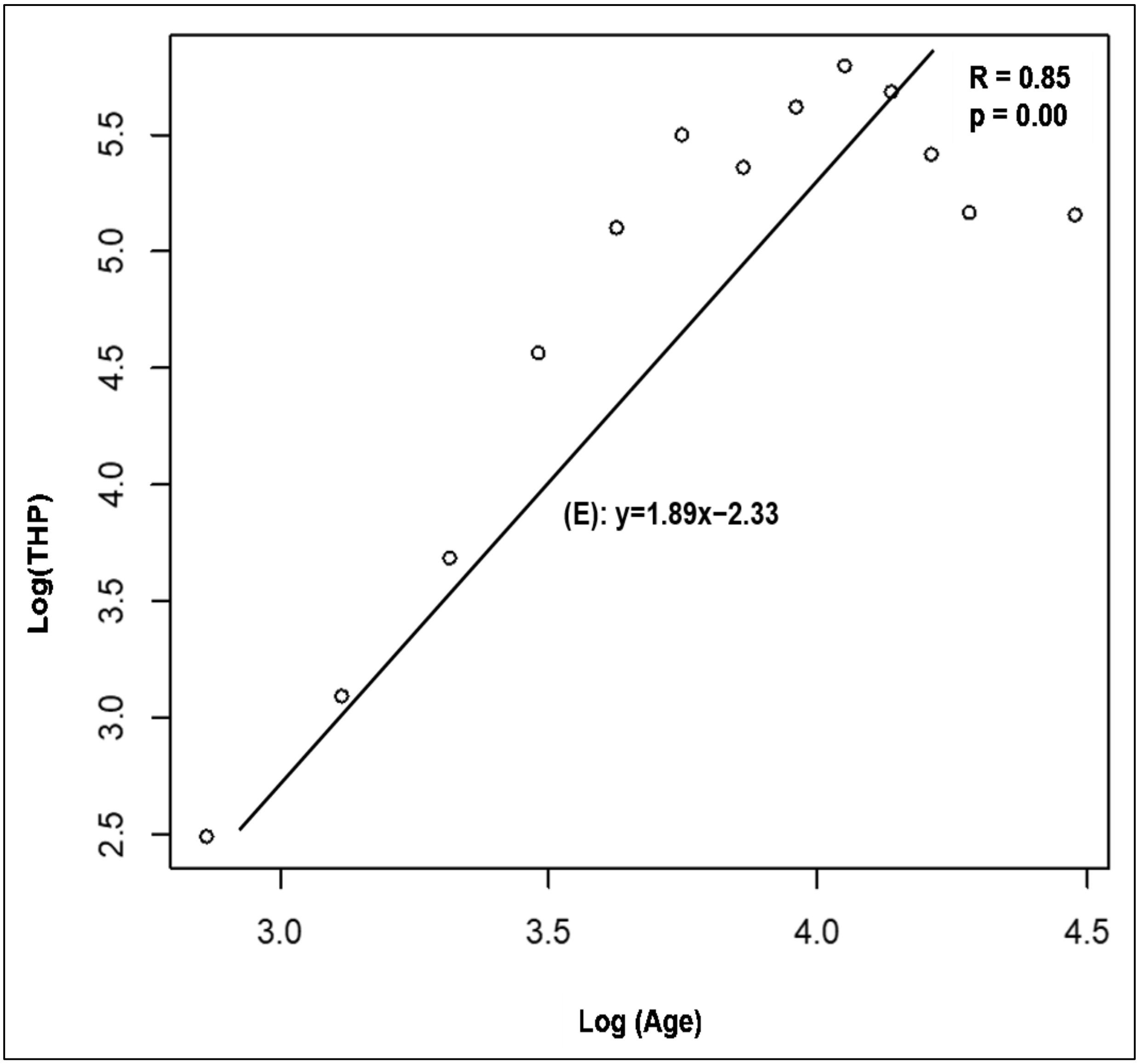

Figure 6. Pearson correlation between age and high blood pressure cases recorded at Korhogo Regional Hospitalfrom 2016 to 2021. Log (THP) = logarithm of the total cases of high blood pressure cases for the years 2016, 2017, 2018, 2019, 2020, and 2021. Log (Age) = logarithm of hypertensive patient age (age average values for each generated age-class intervals) during the period 2016 - 2021.

Table IV. Hypertensioncases frequency distribution across generated age class interval groups.

Age	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	>75	Total
Female	5	15	28	59	90	137	112	138	171	143	115	91	95	1199
Male	7	7	12	37	75	108	102	140	158	152	111	85	79	1073
Total	12	22	40	96	165	245	214	278	329	295	226	176	174	2272

Empirical distribution function of high blood pressure patient'sage feature at Korhogo Regional Hospital from 2016 to 2021.

Empirical distribution function of hypertension cases across generated age-class intervals revealed a similar distribution pattern between male and female hypertensive populations (Figure 7). Moreover, the same analysis showed that more than half of the hypertensive patient's population was aged 45 years or older (Figure 7). In addition, it is noteworthy to underline that hypertensive patient's median age was very close to the mean age. The Shapiro normality test indicated that hypertensive patients cases, based on the generated age-class intervals, followed a normal distribution (p = 0.43).

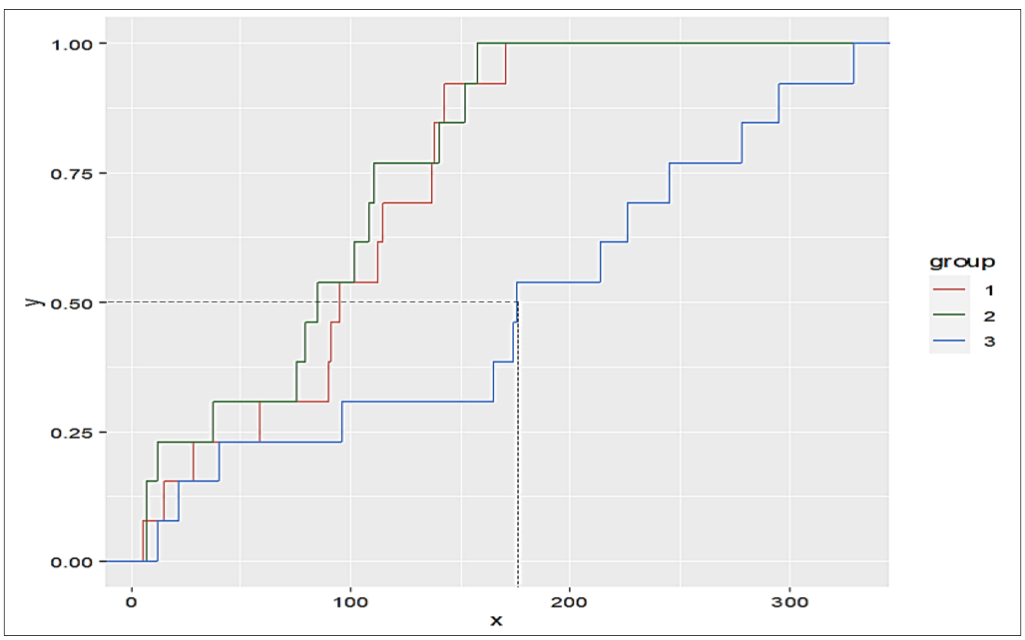

Figure 7. High blood pressure cases empirical distribution function by age class interval. The x-axis represents the logarithm value of hypertensive patient's frequency for each generated age class interval, and the y-axis represents the probability of high blood pressure cases for each generated age class. Groups 1, 2, and 3 refer to female, male, and all hypertensive patients, respectively.

Assessment of combined effect of anthropomorphic parameters (age and sex) on the increasing of hypertension cases:

Based on the previous results, the hypertensive population was divided into two groups: young patients (≤ 45 years) and older patients (> 45 years). ANOVA revealed a significant difference between these two groups in terms of hypertension case frequency ($p = 0.00$), confirming a markedly higher prevalence of hypertension among patients over 45 years (Figure 8A). Combining the anthropometric parameters age and sex, high blood pressure population was further categorized into four subgroups: (i) young females (YF), (ii) young males (YM), (iii) older females (OF), and (iv) older males (OM). Variance analysis among these subgroups also showed a significant difference ($p < 0.05$), suggesting that age remains a discriminating factor independent of sex. However, Tukey's multiple comparison test confirmed that only age significantly influenced hypertension frequency ($p < 0.05$), whereas sex did not ($p > 0.05$) (Figure 8B; Table V). Finally, a chi-square test of independence was performed to evaluate the interaction between age and sex on hypertension increasing cases. The calculated χ^2 (15.5) was lower than the theoretical value (21.02), indicating no significant interaction between age and sex in explaining hypertension increasing cases. In other words, the effect of age is independent of sex feature in characterizing the hypertensive population.

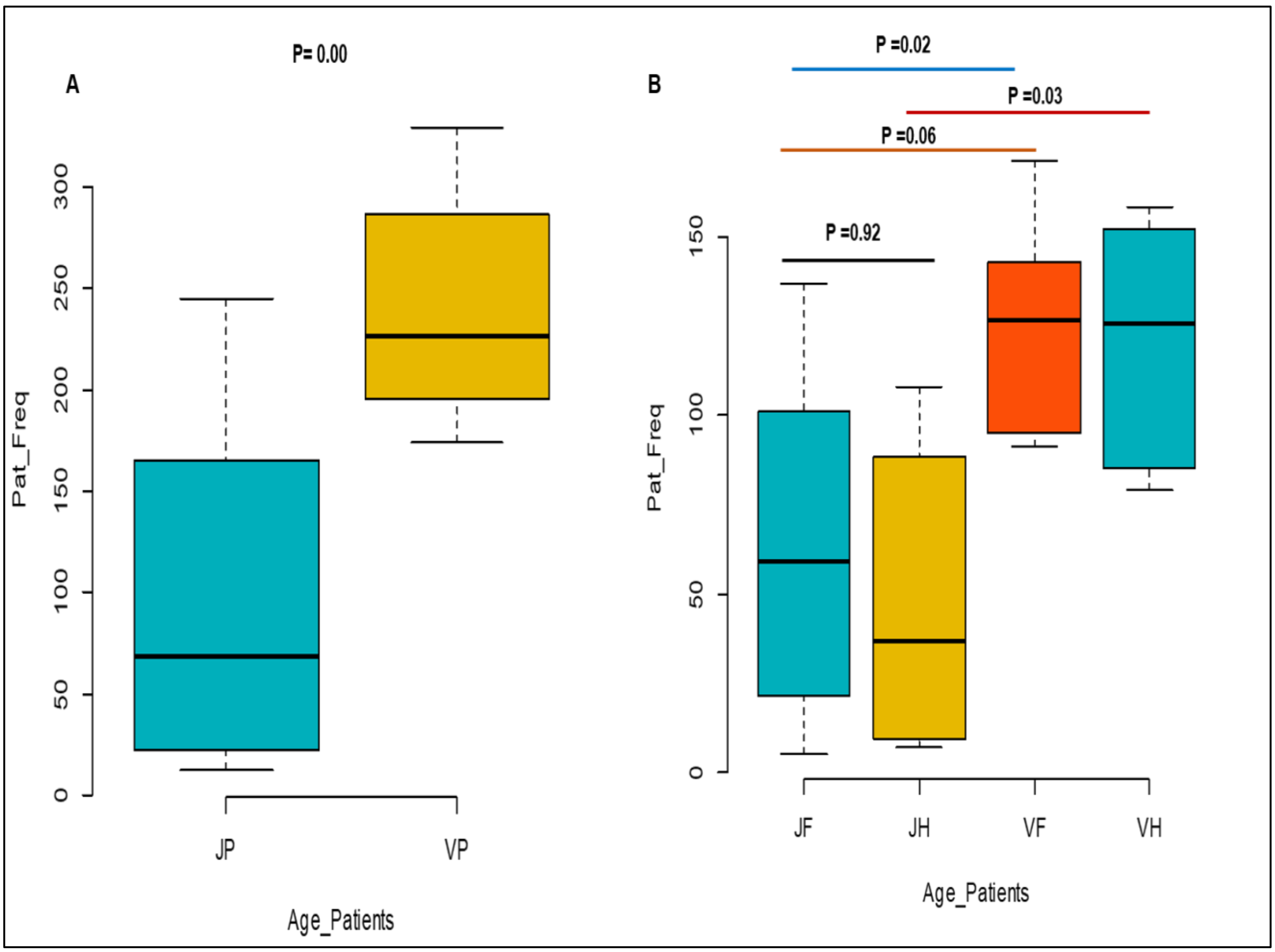

Figure 8. (A) Comparative analysis of variance between young (JP) and older (VP) hypertensive populations. (B) Multiple comparison analysis of frequencies and/or means of hypertensive populations according to age and sex. The acronyms JF, JH, VF, and VH refer to young females, young males, older females, and older males, respectively

Table V. Tukey's test: Multiple comparative test of high blood pressure cases population frequencies based on anthropometric parameters, i.e., age and sex.

	Difference	Lower Bound	Upper Bound	P-value
JH – JF	-14	-75.79	47.79	0.92^{NS}
VH – JF	61.79	-2.53	126.1	0.06^{NS}
VH – JF	57.12	-7.2	121.43	0.09^{NS}
VF – JH	**75.79**	**11.47**	**140.1**	**0.02*****
VH – VF	**71.12**	**6.8**	**135.43**	**0.03*****
VH – VF	-4.67	-71.41	62.08	0.99^{NS}

NS: No-significant: P> 0, 05. ***P<0.05. JF, JH, VF, and VH refer, respectively, to young female patients, young male patients, older female patients, and older male patients.

Yearly increasing dynamism of hypertension cases according to cholesterolemia and glycemia:
The present analysis included 693 hypertensive patients, comprising 324 males and 369 females. The average values of cholesterolemia and glycemia were 1.98 g/L and 1.07 g/L respectively (Table VI). The analysis identified 173 hyperglycemic patients, with a maximum glycemia of 5.16 g/L, and 12 hypoglycemic patients, with a minimum glycemia: of 0.40 g/L (Table VI). Descriptive statistics mainly suggested a stable glycemia and cholesterolemia over the study period (2016–2021) in the hypertensive population (Figure 9). ANOVA indicated no significant yearly variance difference for glycemia (p = 0.11) and cholesterolemia (p = 0.08). In other words, glycemia and cholesterolemia did not influence high blood pressure cases increasing dynamism.

Table VI. Descriptive statistics of glycemia and cholesterolemia in the hypertensive population recorded at CHR Korhogo from 2016 to 2021.

	glycemia (g/L)	cholesterolemia
Minimum	0.40	0.33
Maximum	5.16	4.61
Mean	1.07	1.98
Median	0.95	1.96
Standarddeviation	0.51	0.56

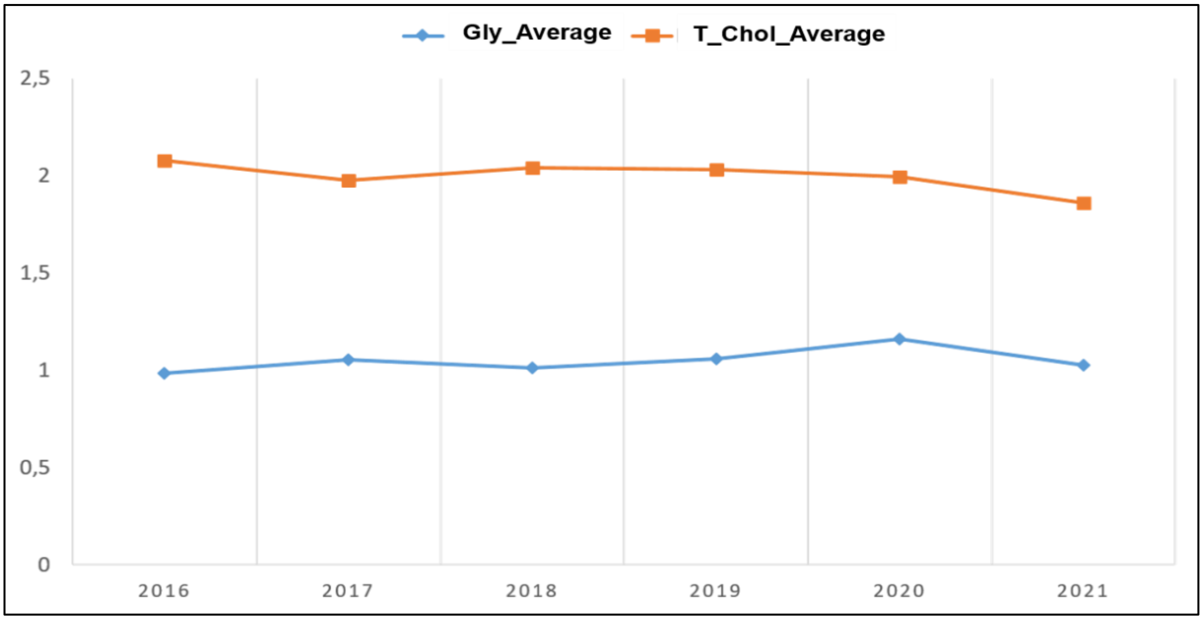

Figure 9. Yearly dynamism of cholesterolemia and glycemia in hypertensive patients without a family history at CHR Korhogo, from 2016 to 2021.

Relationshipbetween age, cholesterolemia and glycemia impacting hypertension increasing cases:
Spearman correlation analysis revealed a very weak and non-significant correlation between age and cholesterol levels (Rho = -0.07, p > 0.05), while revealing a significant correlation between age and blood glucose (p = 0.03) (Table VII). The hypertensive population was stratified into young (≤ 45 years) and older (> 45 years) hypertensive patients. In addition, Student's t-test indicated significantly high level of glycemia (hyperglycemia) in ageing high blood pressure patients as opposed to younger hypertensive patients (p = 0.03), with 134 hyperglycemic cases in the older hypertensive group versus 35 in the younger hypertensive group (Figure 10). Notably, glycemia showed a stronger correlation with age among younger patients (Rho = 0.16, p = 0.04), suggesting that it may serve as a useful predictor of age, particularly in younger patients in monitoring high blood pressure.

Table VII.Spearman correlation between high blood pressure patient's age,blood glucose and cholesterol level.

	Age (1)	glycemia (2)	Cholesterolemia (3)
1	1		-
2	**0.03*****	1	
3	-0.07^{NS}	0.10^{NS}	1

NS: No-significant p>0.05; ***p≤0.05.

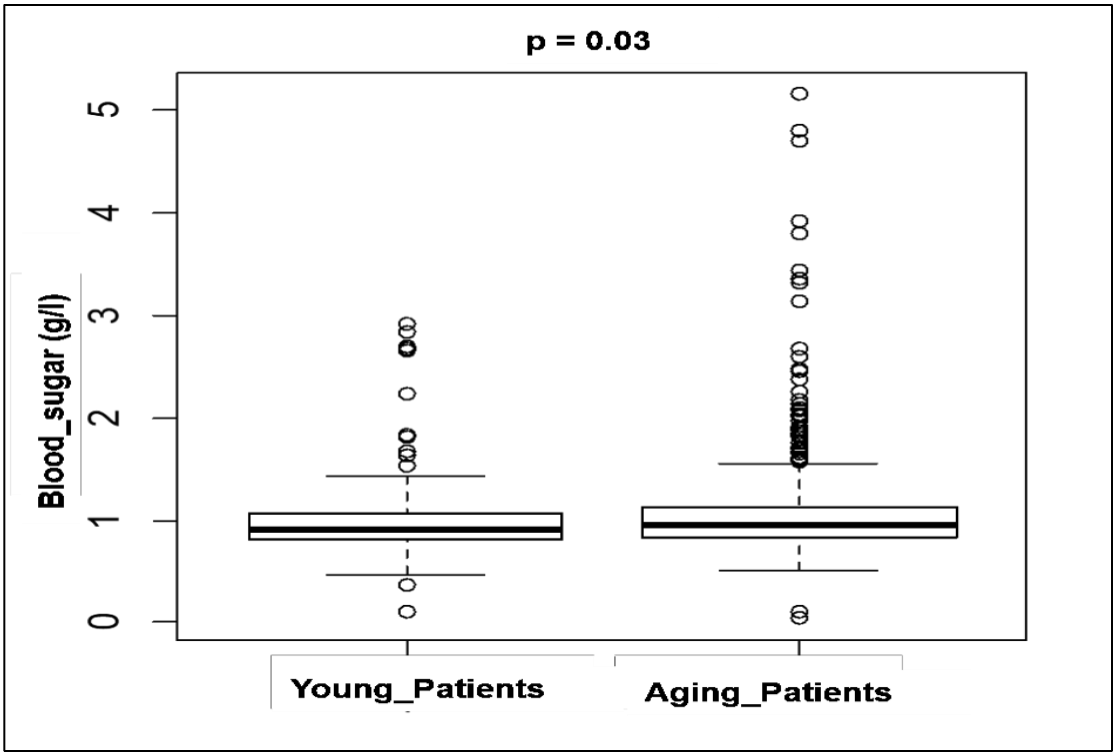

Figure 11. Multivariate statistical and comparative analysis of glycemia between young and aging hypertensive populations.

Discussion:

Studied hypertensive population consisted of 1199 females and 1073 males. Empirical distribution function regarding the hypertensive patients suggested an increasing of high blood pressure casesin Korhogo district with a growth factor ranging between five (5) and six (6) for male and female patients, respectively. This result acclaims a female predominance inthe studiedhypertensive population. These findings are consistent with Emmanuel (2021), who, in a study conducted at the Point G University Hospital in Mali, reported a hypertensive patient population of 33 women and 23 men [9]. A similar observation was made at the Military Hospital of Abidjan by Anoman (2014), where 62.9% of hypertensive patients were women and 37.1% were men [10]. This observation differs from that reported by Okpomi (2016), who noted a male predominance [11].

However, some studies have not observed a female predominance in recorded hypertension cases [12, 13]. ANOVA test and the analysis of the empirical distribution function of hypertensive patients by sex indicated a non-significant variance difference between female and male hypertensive sub-group. In other words, observed differences between male and female high blood pressure cases were not statistically significant. In Sub-Saharan Africa, women are as likely to be hypertensive as men [14, 15]. Therefore, the growth dynamics of hypertension cases observed at CHR Korhogo from 2016 to 2021 cannot be estimated based on patient sex [16]. Empirical function clearly showed that hypertension increasing and dynamism is sex free in Korhogo district. Hypertension is a complex condition resulting from the interaction between genetic and environmental factors [17]. The environment influences individual characteristics and behavior. Unlike sex, the yearly factor showed a significant variance difference regarding the growth dynamics of hypertensive patient frequencies over the entire study period (2016-2021) in Korhogo, northern Cote d'Ivoire [18]. The linear regression model explaining the increase in the frequency of hypertensive patients over the years proved to be an excellent predictive model. Indeed, the WHO reports that, in general, the prevalence of hypertension is high in Africa and tends to increase in most countries over time [19]. Understanding the extent of hypertension as a major public health issue and seeking solutions to curb it requires knowledge of prevalence and its variation over time and space. It also requires understanding the determinants of hypertension, identifying high-risk groups for cardiovascular disease in general, and developing, implementing, and evaluating prevention and control strategies [20, 21]. Hypertension remains a persistent problem due to its frequency and the risk of cardiovascular and renal complications. Its prevalence is steadily increasing in developing countries due to population growth and aging, as well as a rise in obesity and overweight, in parallel with urbanization [16, 18, and 22].

According to the WHO, the number of hypertensive individuals in developing countries is expected to increase by 80% between 2000 and 2025, compared to only 24% in developed countries. This study revealed a predominance of hypertensive patients over 45 years of age in the overall analyzed population, suggesting an aging hypertensive population [18]. Furthermore, the results showed a strong positive correlation close to one (1) between age and the increasing number of hypertension cases, making age an excellent predictor of the growth dynamics of hypertension at CHR Korhogo from 2016 to 2021.These results differ from those of Agoudavi (2010) in Togo and the Ministry of Health and Family Planning in Madagascar (2005) [23, 24], which reported relatively younger hypertensive populations aged 30-45 years. However, our findings are consistent with Dago et al. (2017, 2022), who reported a high prevalence of hypertension among patients aged 50 and above [6, 18]. The predictive model associating anthropometric parameters i.e. age of hypertensive patients and as well, frequency of hypertension cases at CHR Korhogoindicated that age is an excellent feature in predicting hypertension increasing rate. These results align with those of Kayima et al. (2015) and Tougouma et al. (2018), who reported that the prevalence of hypertension increases with age [13, 25].

However, our results differ from Pessinabaet al. (2013), who found no association between age and the occurrence of hypertension [26]. Interestingly, Mina et al., (2015) suggested low glycemic food index as decreasing systolic and diastolic blood pressure. In the same trend, our study supported a statistical significative correlation between hypertension cases and glycemia, making this biological parameter an interesting feature in monitoring hypertension troubles in Korhogo district [27]. Indeed, our previous study revealed a high prevalence of the rs12255372 genetic variant of the TCF7L2 a gene associated with the risk of type 2 diabetes (T2D), in non-diabetic population i.e. hypertensive population, in Northern Cote d'Ivoire [28]. In addition, Dago et al., (2018) [16] study revealed a conflicting results assessing the relationship between age and weight parameters in characterizing hypertensive patient gender in Northern of Cote d’Ivoire.

Of note, even if the present study revealed stable values of biological parameters i.e. cholesterolemia and glycemia, it is noteworthy to underline that, the cholesterol rate resulted to be an independent factor with respect to hypertensive patients age and as well to blood sugar level. Indeed, high cholesterolemia (hypercholesterolemia) and high blood pressure have a complicated relationship. Studies indicate that high blood pressure (hypertension) and hypercholesterolemia are two significant risk factors for cardiovascular diseases, including heart disease and stroke. Both conditions can independently and synergistically increase the risk of severe health outcomes [29; 30], Research indicates a complex relationship between high blood pressure and hypercholesterolemia. Elevated cholesterolemia can lead to increased blood pressure, and vice versa. For instance, a study found that an increase in cholesterolemia often results in higher blood pressure, which can lead to hypertension [29], Additionally, a high-saltdiet, which is known to increase blood pressure, has also been shown to elevate cholesterolemia, potentially through the activation of hepatic enzymes critical to cholesterols ynthesis[31],

Retrospective design, reliance on hospital records, and potential underrepresentation of patients with a family history of hypertension may constitute limitations of the study. Future research taking these factors into account is needed to better assess the distribution of hypertension cases according to temporal, anthropometric, and metabolic characteristics at Korhogo Regional Hospital.

Conclusion:

The dynamism increasing of hypertension cases in the Korhogo region result to be significantly correlated with yearly feature. Indeed, thehypertensive cases exhibited a progressive increase over the years, with growth factors of 5 and 6 for female and male patients, respectively. This progression is age-dependent, with hypertension, being more pronounced in individuals over 45 years, and in some case is associated with hyperglycemia. In contrast, to high blood pressure, sex and cholesterolemia appear to have no significant influence on the empiric distribution function in describing hypertension-increasing dynamism in Northern Cote d’Ivoire. Considering as a whole, monitoring age and blood sugar level that include live style and as well environment, could therefore help in improving hypertension prevention strategies.

Ethical considerations:
The study was conducted in accordance with the Declaration of Helsinki and received approval from the National Committee for Ethics and Research (CNER) of the Ministry of Health, Public Hygiene, and Universal Health Coverage of Cote d'Ivoire. All patients whose records were included in the study provided written informed consent after being fully informed about the study procedures.

Authors Contributions:
DDN, DO and KAF setup the experiment. DDN and BBDS write the paper. GLSE give a significant contribution in writing the paper. DDN supervise and perform computational biostatical analysis. KAF and DO give a contribution in clinical data interpretation. BBDS, DO and DT give a contribution in the computational statistical analysis. All authors revise the manuscript.

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